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AN OUTLINE

OF

THE FIRST PRINCIPLES

OF

BOTANY.

BY

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ETC. ETC. ETC.

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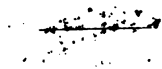
PREFACE.



THE want of some English work on Botany, at once of a mere elementary character, and comprehending all the more important points of the science, has given rise to the publication of the following pages. The propositions which they contain are such as it is of the most indispensable importance for a student to understand; and they all appear to be strictly deducible either from the facts recorded by observers worthy of confidence, or from the experience of the author. They form the basis of the Lectures delivered by him in the University of *London*, and are purposely divested of *illustrative* or explanatory matter; his only

object having been to reduce the first principles of Botany to their simplest form.

No person can be considered a Botanist who is unacquainted with the nature of the evidence upon which such of these propositions as are indisputable, are founded; or by which it is supposed that others, which are less certain, can be disproved. Acquiring this kind of knowledge constitutes the study of Vegetable Comparative Anatomy, or Organography; a curious and interesting subject, upon which Systematic Botany entirely depends.

Whatever value may attach to this little work would have been essentially diminished by the introduction of theories unsupported by what may be reasonably considered satisfactory evidence. They have, therefore, been avoided as far as the nature of the subject, in which much is incapable of direct demonstration, would *permit.*

The wish of the author has been to sketch a slight but accurate outline, the details of which are to be filled up by the reader himself, who, for this purpose, cannot do better than consult the "Organographie Végétale" of Decandolle, or the "Elementa Philosophiæ Botanicæ" of Link; two works of the highest reputation, in the general accuracy of which the student may place confidence. He will easily see what parts of either are merely hypothetical, and what are founded upon direct observation; and he will find that it is chiefly the latter class which applies to the propositions introduced into this book.

Each paragraph has a separate Number; and in all cases in which allusion is made in one paragraph to a subject of importance incidentally adverted to in another, the Number of that other is quoted. For instance take paragraph 51.

51. *The compound organs are the axis* (52) *and its appendages* (158).

Here the Numbers after "Axis," and "Appendages," shew in what paragraphs an explanation of the meaning of these words is to be found.

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1. PLANTS are not separable from animals by any absolute character; the simplest individuals of either kingdom not being distinguishable by our senses.

2. Animals are for the most part incapable of multiplying by mechanical or spontaneous division of their trunk.

3. Plants are for the most part congeries of individuals, multiplying by spontaneous or artificial division of their trunk or axis.

4. Generally speaking, the latter are fixed to some substance from which they grow, are destitute of locomotion, and are

nourished by absorption through their cuticle (38).

5. Plants consist of a membranous transparent tissue, formed by a combination of oxygen, hydrogen, and carbon, to which azote is occasionally superadded.

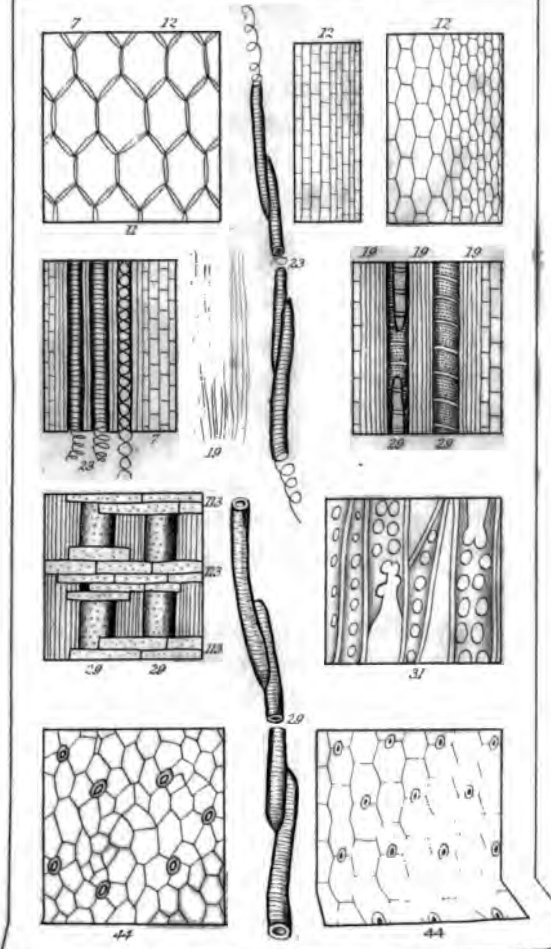
6. Their tissue appears under four forms, viz. cellular tissue, woody fibre, spiral vessels, and ducts. These are called elementary organs.

I. ELEMENTARY ORGANS.

7. Of these CELLULAR TISSUE (Tela cellulosa, *Lat.;* Tissu cellulaire, *Fr.*; Pulp and Parenchyma, *of old writers;* Zellgewebe, *Germ.*) is the only form universally found in plants; the other forms are often either partially or entirely wanting.

8. Cellular tissue is composed of transparent vesicles, the sides of which are not perforated by visible pores (17).

9. Each vesicle is a distinct individual, *cohering* with the vesicles with which it *is in juxtaposition.*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10. Therefore, the apparently simple membrane that divides two contiguous cells is in fact double.

11. If the adhesion of the contiguous cells be imperfect, spaces will exist between them. Such spaces are called *intercellular passages.*

12. The vesicles of cellular tissue, when separate, are round or oblong; when slightly and equally pressed together, they acquire an hexagonal appearance; stretched lengthwise, they become prismatical, cylindrical, or fusiform.

13. Cellular tissue, the vesicles of which fit together by their plane faces, is called *parenchyma.*

14. Cellular tissue, the vesicles of which are elongated and overlie each other at the extremities, is called *prosenchyma.*

15. *Parenchyma* constitutes all the pulpy parts of the medulla or pith (82), the medullary rays (113), a portion of the bark (102), and all that is interposed

between the veins of the leaves and of other appendages of the axis.

16. *Prosenchyma* is confined to the bark and wood, in which it is mixed with woody fibre (19).

17. The function of the cellular tissue is to transmit fluids in all directions; the membrane of which it is composed is, therefore, permeable, although not furnished with visible pores (8).

18. It has been supposed that the cellular tissue is self-productive, one vesicle giving birth to many others.

19. WOODY FIBRE (Vasa fibrosa, *Lat.*; Tissu cellulaire allongé, *Fr.*; Clostres, *Fr.*; Baströhren, *Germ.*) is tissue consisting of elongated tubes tapering to each end, and, like the vesicles of cellular tissue, imperforate to the eye.

20. It may be considered a form of the cellular tissue itself, to which it is frequently referred.

21. It is found in the wood, among the

parenchyma of the liber (104), and in the veins of leaves, and of other appendages of the axis.

22. Its functions are to give strength to the vegetable fabric, and to serve as a medium for the passage of fluid from the lower to the upper extremities.

23. SPIRAL VESSELS (Vasa spiralia, *Lat.*; Trachées, *Fr.*; Spiralgefässe, *Germ.*) consist of elastic tissue twisted spirally into the form of a cylinder, and capable of unrolling.

24. They are found in the medullary sheath (86), and in all parts that emanate from it in an ascending direction; viz. the veins of the leaves, and every thing that is a modification of them.

25. They are not found in any part which is formed in a downward direction; and are consequently absent from the wood, bark, and root.

26. The function of the spiral vessels *is unknown*.

27. They only exist in plants propagated by the agency of sexes.

28. Hence the two primary divisions of the vegetable kingdom; viz., Vasculares, or plants furnished with spiral vessels and propagated by the agency of sexes; and Cellulares, or plants destitute of spiral vessels and not propagated by the agency of sexes.

29. Ducts (Fausses tracheés, *Fr.*; Saftröhren, *Germ.*) are transparent tubes, the sides of which are marked with dots, or bars, or transverse streaks.

30. Sometimes they have the appearance of spiral vessels, from which they are known by not being capable of unrolling.

31. Their sides are not perforated by visible holes or pores, except in Coniferæ, and Cycadeæ, in which perforations *are supposed to exist.*

32. They are found among the woody *fibre, exist* in great abundance in the *wood, and their* ends are in immediate

connexion with the loose cellular tissue occupying the extremities of the fibres of the roots.

33. Their functions have not been accurately determined. It is probable that they serve for the passage of air.

34. The mode in which the different forms of tissue are developed is unknown.

35. There are no other elementary forms of tissue. *Air-vessels, Reservoirs of oil, Lenticular glands, Proper vessels,* are all either distended intercellular passages, or cavities built up with cellular tissue.

36. When such cavities are essential to the existence of a species, they are formed by a regular arrangement of cellular tissue in a definite and unvarying figure; *Ex.* Water-plants. When they are not essential to the existence of a species, they are mere irregular distensions or lacerations of the tissue; *Ex.* Pith of the *Walnut* Tree.

37. All these forms of tissue are enclosed within a skin called the cuticle.

38. The CUTICLE is an external layer of parenchyma, the cells of which are compressed, and in a firm state of cohesion.

39. The spaces seen upon the cuticle, when examined by a microscope, represent these cells.

40. It is, therefore, not a peculiar membrane, but a form of cellular tissue.

41. It is spread over all parts of plants, except the stigma (345).

42. The mass of cellular tissue lying beneath the cuticle of the bark is called the *epidermis*.

43. The cuticle is often furnished with stomata.

44. STOMATA are oval spaces lying between the sides of the cells, opening into intercellular cavities in the subjacent tissue, and bordered by a rim, the nature of which is not well known.

45. It is not improbable that this appearance of a rim is due to the juxtaposition of two elastic vesicles, closing up or opening the aperture on which they lie, according to circumstances.

46. Stomata are found abundantly upon leaves, particularly on the lower surface of those organs; occasionally upon all parts that are modifications of leaves, especially such as are of a leafy texture; and on the stem.

47. Stomata have not been found upon the roots, nor on colourless parasitical plants, nor the submersed parts of plants, nor on cellular plants destitute of ducts; they are rare, or altogether absent from succulent fruits, and from all parts in a state of anamorphosis.

48. Any part in which there is an unusual degree of cellular developement, is said to be in a state of *anamorphosis.*

49. The function of stomata is to facilitate evaporation.

II. COMPOUND ORGANS.

50. From peculiar combinations of the elementary organs are formed the compound organs.

51. The compound organs are the axis (52) and its appendages (158).

52. The AXIS may be compared to the vertebral column of animals.

53. It is formed by the developement of an embryo, or of a leaf-bud.

54. An *embryo* is a young plant, produced by the agency of sexes, and developed within a seed.

55. A *leaf-bud* is a young plant, produced without the agency of sexes, and either enclosed within rudimentary leaves called scales, or naked.

56. Seeds propagate the species.

57. Leaf-buds propagate the individual.

58. All the phenomena connected with the growth of plants are caused by an inherent vital action.

59. When the vital action of a seed or


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bud is excited, the tissue developes in three directions, the one upwards, the other downwards, and the third horizontal.

60. That part which developes downwards is called the descending axis or root; that upwards, the ascending axis or stem; and the part from which these two axes start is called the *collet* or neck.

61. This elongation in opposite directions takes place simultaneously; hence it follows that all plants must necessarily have an ascending and descending axis, or a stem and root.

62. The only apparent exceptions to this are vesicular Algæ.

III. ROOT.

63. The root is formed by the descending and dividing fibres of the stem.

64. Anatomically it differs from the stem in the absence of spiral vessels (23), *of pith (15)*, and of buds, and in the want *of stomata* (44).

65. The functions of the root are to fix plants in the earth, and to absorb nutriment from it.

66. This absorption takes place almost exclusively by the extremities, which consist of a lax coating of cellular tissue lying upon a concentric layer of woody fibre, in the midst of which is placed a bundle of ducts.

IV. STEM.

67. The stem is produced by the successive developement of leaf-buds (142), which elongate in opposite directions.

68. If an annular incision be made below a branch of an Exogenous plant (80), the upper lip of the wound heals rapidly, the lower lip not: the part above the incision increases sensibly in diameter, the part below does not.

69. If a ligature be made round the bark, below a branch, the part above the ligature swells, that below it does not *swell.*

70. Therefore the matter which causes the increase of Exogenous plants in diameter descends.

71. If a growing branch is cut through below a leaf-bud, that branch never increases in diameter between the section and the first bud below it.

72. The diameter of all Exogenous stems increases in proportion to the number of leaf-buds that is developed.

73. The greater the number of leaf-buds above a given part, the greater the diameter of that part; and *vice versâ.*

74. In the spring the newly forming wood is to be traced in the form of fibres descending from the leaf-buds; that which is most newly formed lying on the outside, and proceeding from the most newly developed buds.

75. Therefore the descending matter, by successive additions of which Exogenous plants increase in diameter, proceeds from the leaf-buds.

76. Their elongation upwards gives rise to new axes, with the appendages of the same; their elongation downwards increases the diameter of that part of the axis which pre-existed, and produces roots.

77. Hence, while the stem is formed by the successive evolution of leaf-buds, the root, which is the effect of that evolution, has no leaf-buds.

78. The leaf-buds thus successively developed are firmly connected by the cellular tissue of the stem, which proceeds from the bark inwards, or from the circumference to the centre.

79. The stem varies in structure in three principal modes.

80. In vascular plants it is either formed by successive additions to the outside of the wood, when it is called *Exogenous;* or by successive additions to its centre, when it is called *Endogenous.* In Cellular plants it is formed by the union of the bases of the leaves, or by simple

elongation or dilatation where no leaves or buds exist.

81. The stem of EXOGENOUS plants may be distinguished into the Pith, the Medullary Sheath, the Wood, the Bark, the Medullary Rays, and the Cambium.

82. The PITH consists of cellular tissue, the vesicles of which are in a slightly compressed state; it occupies the centre of the stem.

83. It never alters in diameter after it is once formed.

84. It is produced by the elongation of the axis upwards.

85. It serves to nourish the young buds until they have acquired the power of procuring nourishment for themselves.

86. The MEDULLARY SHEATH consists of spiral vessels and ducts.

87. It immediately surrounds the pith, projections of which pass through it into the medullary rays (113).

88. It is in direct communication with *the leaf-buds* and the veins of the leaves.

89. It carries upwards the fluid absorbed either immediately from the earth or through the intervention of the alburnum (101), and conducts it into the leaves.

90. The WOOD lies upon the medullary sheath, and consists of concentric layers.

91. It is formed by the successive adhesion of the descending axes of the buds, and by the distension or increase of the cellular tissue of the medullary rays.

92. The first concentric layer lies immediately upon the medullary sheath and pith, and consists of woody fibre and ducts.

93. Each succeeding concentric layer consists of an interior stratum of cellular tissue, and an outer stratum of woody fibre and ducts.

94. Therefore, all the concentric layers that succeed the first may be considered to consist of wood and pith, and to be the same as the first, with the exception of *the absence* of a medullary sheath.

95. A concentric layer, once formed, never alters in dimensions.

96. Each concentric layer, which is distinctly limited, is the produce of one year's growth.

97. Therefore, the age of an Exogenous plant may generally be known by the number of concentric circles of the wood.

98. The secretions of plants are deposited first in the oldest concentric layers; while those layers which are most recently formed are either empty, or contain but a slight deposit.

99. When the tissue of the concentric layers is filled with secretions, it ceases to perform any vital functions.

100. The dead and fully formed central layers are called the *heart-wood.*

101. The living and incompletely formed external layers are called the *alburnum.*

102. Upon the outside of the wood lies the BARK, which, like the wood, consists of concentric layers.

103. Each concentric layer is composed

of woody fibre and ducts, covered externally by a layer of cellular tissue.

104. The woody fibre and ducts constitute the *liber*.

105. The exterior cellular tissue constitutes the cellular integument or *epidermis*.

106. The concentric layers of the wood and bark are the reverse of each other, the former increasing externally, the latter internally; the former having a zone of cellular tissue inside, and of woody fibre and ducts outside; the latter having a zone of woody fibre with a few ducts inside, and of cellular tissue outside.

107. The concentric layers of the bark are formed at the same period, and under the same circumstances, as those of the wood.

108. Therefore, the number of concentric layers in the one or the other is the same.

109. But while the concentric layers *of the* wood are imperishable except from

disease, those of the bark are continually destroyed by the distension of the stem; and hence the bark is always perishing naturally, while the wood sustains no loss.

110. The secretions of a plant are often deposited in the bark in preference to any other part.

111. Hence chemical or medicinal principles are often to be sought in the bark rather than in the wood.

112. The immediate functions of the bark are to protect the young wood from injury, and to serve as a filter through which the descending elaborated juices of a plant may pass horizontally into the stem.

113. The MEDULLARY RAYS or PLATES consist of compressed parallelograms of cellular tissue (*muriform cellular tissue*).

114. They connect together the tissue of the trunk, maintaining a communication between the centre and the circumference.

115. They act as braces to the woody fibre and ducts of the wood.

116. *Cambium* is the viscid secretion which, in the spring, separates the alburnum from the liber.

117. It is supposed to be destined to afford a proper pabulum for the descending fibres of the buds.

118. I believe it exclusively gives birth to the new medullary rays.

119. As Exogenous plants increase by annual addition of new matter to their outside, and as their protecting integument or bark is capable of distension in any degree, commensurate with the increase of the wood that forms below it, it follows, taking all circumstances into consideration, that there are no assignable limits to the life of an Exogenous tree.

120. The stem of ENDOGENOUS plants offers no distinction of Pith, Medullary *Rays, Wood,* and Bark.

121. It is formed by the intermixture *of bundles* of vascular tissue among a

mass of cellular tissue, the whole of which is surrounded by a zone of cellular tissue and woody fibre, inseparable from the stem itself, and therefore not bark.

122. It increases by the successive descent of new bundles of vascular tissue down into the central cellular tissue.

123. The vascular bundles of the centre gradually force outwards those which were first formed, and in this way the diameter of a stem increases.

124. The diameter of the stem of an endogenous plant is determined by the power its tissue possesses of distending, and on its hardness.

125. When the external tissue has once become indurated, the stem can increase further in diameter.

126. When the tissue is soft and capable of continual distension, there is no re certain limits to the life of an Endogenous *than* of an Exogenous tree.

127. *Generally*, the terminal bud only

of Exogenous plants is developed; but very often a considerable number develope; *Ex.* Asparagus.

128. When a terminal bud only of an Endogenous plant developes, the stem is cylindrical; *Ex.* Palms; when several develope, it becomes conical; *Ex.* Bamboo.

129. In Cellular plants no other stem is formed than what arises from the simple union of the bases of the leaves to the original axis of the bud from which they spring, and which they carry up along with them. This subject is but ill understood.

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130. The ascending direction of the stem, upon its first developement, is frequently deviated from immediately after.

131. It often burrows beneath the earth, when it is vulgarly called a *creeping root.* Sometimes the internodia (137), become much thickened, when what are called *tubers* are formed; or the stem lies *prostrate* upon the earth, emitting roots

from its under side, when it is called *rhizoma*.

132. If it distend underground, without creeping or rooting, but always retaining a round or oval figure, it is called a *cormus*.

133. All these forms of stem are vulgarly called roots.

134. No root can have either scales, which are the rudiments of leaves, or nodi, which are the rudiments of buds. A *scaly root* is, therefore, a contradiction in terms.

135. The ascending axis, or stem, has nodi and internodia.

136. *Nodi* are the places where the leaves are expanded and the buds formed.

137. *Internodia* are the spaces between the nodi.

138. Whatever is produced by the evolution of a leaf-bud (142) is a branch.

139. A *spine* is the imperfect evolution of a leaf-bud, and is therefore a branch.

140. All processes of the stem which

are not the evolutions of leaf-buds, are mere dilatations of the cellular integument of the bark. Such are *prickles.* (*Aculei,* Lat.)

V. LEAF-BUDS.

141. Buds are of two kinds, Leaf-buds and Flower-buds.

142. LEAF-BUDS (*Bourgeon,* Fr.) consist of rudimentary leaves surrounding a vital point, the tissue of which is capable of elongation, upwards in the form of stem, and downwards in the form of wood or root.

143. FLOWER-BUDS (*Bouton,* Fr.) consist of rudimentary leaves surrounding a point, which does not elongate after it is once developed, and assumes, when fully developed, the form of sexual apparatus.

144. Notwithstanding this difference, a leaf-bud sometimes indicates a tendency to become a flower-bud; and flower-buds frequently assume the characters of *leaf-buds; Ex.* Monstrous Pears.

145. Leaf-buds are of two kinds, the regular and the adventitious.

146. *Regular Leaf-buds* are only found in the axillæ of the leaves.

147. They exist in a developed or undeveloped state in the axillæ of all leaves, and of all modifications of leaves.

148. Therefore, they may be expected to appear at the axillæ of scales of the bud, of stipulæ (183), of bracteæ (229), of sepals (290), of petals (291), of stamens (302), and of carpella (354); in all of which situations they are generally undeveloped.

149. They are frequently not called into action, even in the axillæ of leaves.

150. As regular buds are only found in the axillæ of leaves, or of their modifications; and as branches are always the developement of buds, it follows that whatever may be the arrangement of the leaves, the same will be the disposition of the branches; and *vice versâ*.

151. This corresponding symmetry is,

however, continually destroyed by the unequal developement of the buds.

152. Leaf-buds which are formed among the tissue of plants subsequently to the developement of the stem and leaves, are called latent, adventitious, or abnormal.

153. *Adventitious Leaf-buds* may be produced wherever there is an anastomosis of woody fibre.

154. They are formed in the root, among the wood, and at the margin or on the surface of leaves.

155. They are constructed anatomically exactly as regular buds, having pith in their centre, surrounded by spiral vessels, and coated over by woody fibre and cellular integument.

156. Hence, as adventitious buds, containing spiral vessels, can be produced from parts such as the root or the wood, in which no spiral vessels previously existed, it follows that this form of tissue is either generated spontaneously, or is

produced by some other tissue, in a manner unknown to us.

157. Leaf-buds have been sometimes confounded with roots by old botanists. A *bulb* is a leaf-bud; a *bulbous root* is a contradiction in terms.

VI. LEAVES.

158. A leaf is an expansion of the bark immediately below the origin of a regular leaf-bud, and is an appendage of the axis (51).

159. Whenever a regular leaf-bud is formed, a leaf, either perfect or rudimentary, is developed also; and *vice versâ*.

160. Leaves are developed alternately, one above and opposite the other, around their common axis; but in consequence of the internodia of the axis being unequally developed, leaves are often opposite or verticillate. They are never produced side by side.

161. In Exogenous plants, the primordial or seed-leaves (cotyledons) are oppo-

site; hence, in such plants the supposed non-developement of the axis takes place during the original formation of the embryo.

162. There is a constant tendency in opposite or verticillate leaves to become alternate.

163. This law applies equally to the arrangement of all parts that are modifications of leaves.

164. A leaf consists of a petiole, a lamina, and a pair of stipulæ.

165. The PETIOLE is the channel through which the vessels of the leaf are connected with those of the stem; it is formed of one or more bundles of spiral vessels and woody fibre, enclosed in a cellular integument.

166. The spiral vessels of the leaf of Exogenous plants derive their origin from the medullary sheath; those of Endogenous plants from the bundles of vascular tissue.

167. The cellular integument of the

petiole is a continuation of that of the bark.

168. When the petiole is leafy and the lamina is abortive, it is called *phyllodium.*

169. When the petiole becomes dilated and hollowed out at its upper end, the lamina being articulated with and closing up its orifice, it is called a *pitcher* or *ascidium.*

170. Sometimes the petiole has no lamina, or is elongated beyond the lamina, and retains its usual cylindrical or taper figure, but becomes very long, and twists spirally; such a petiole is called a *tendril,* (Vrille, *Fr.*)

171. The LAMINA of a leaf is an expansion of the parenchyma of the petiole, and is traversed by veins which are ramifications or extensions of the bundles of vascular tissue of the petiole, or, when there is no petiole, of the stem.

172. The veins either branch in various directions among the parenchyma, anastomosing and forming a kind of net-work,

or they run parallel to each other, being connected by single transverse unbranched veins.

173. The former is characteristic of Exogenous, the latter of Endogenous plants.

174. The principal vein of a leaf is a continuation of the petiole, and runs in a direct line from the base to the apex of the lamina; this vein is called the *midrib*.

175. *Coniferæ* and *Cycadeæ*, tribes the stem of which has an Exogenous structure, have the same arrangement of their veins as Endogenæ.

176. There are two strata of veins, the one belonging to the upper, and the other to the under surface.

177. The upper stratum conveys the juices from the stem into the lamina, for the purpose of being aërated and elaborated; the under returns them into the bark.

178. The lamina is variously divided and formed; it is usually thin and membranous, *with a distinct* upper and under surface;

but sometimes becomes succulent, when the surfaces are often not distinguishable.

179. The upper surface is presented to the sky, the lower to the earth; this position is rarely departed from in nature, and cannot be altered artificially except by violence.

180. A leaf is *simple* when its lamina is undivided, or when, if it is separated into several divisions, those divisions are not articulated with the petiole; *Ex.* Lime Tree, Palm.

181. A leaf is *compound* when the lamina is articulated with the petiole; *Ex.* Orange, Mimosa.

182. The modes in which leaves are divided are distinguished by particular names, such as *pinnated, pinnatifid, bipinnated, bipinnatifid,* and very many others. These terms apply to the mode of division, and are equally applicable to simple and compound leaves.

183. STIPULÆ are attached to each side

of the base of the petiole. They have, if foliaceous, veins, the anatomical structure of which is the same as of the veins of the leaves.

184. Stipulæ are sometimes transformed into leaves; they sometimes have buds in their axillæ; and may be, therefore, considered rudimentary leaves.

185. Whatever arises from the base of a petiole, or of a leaf if sessile, occupying the same place, and attached to each side, is considered a stipula.

186. The stipulæ must not be confounded with cellular marginal appendages of the petiole, as in Apocyneæ.

187. Stipulæ, the margins of which cohere in such a way that they form a membranous tube sheathing the stem, are called *ochreæ; Ex.* Rhubarb.

188. All leaves are originally continuous with the stem; as they grow, an interruption of their tissue at their junction takes place, by which a more or less

complete articulation is formed sooner or later.

189. As soon as the articulation between a leaf and stem is completed, the *Fall of the Leaf* takes place. The cause of this articulation is unknown.

190. All leaves ultimately fall off; evergreen leaves later than others.

191. The mode in which leaves are arranged within their bud is called *vernation, or gemmation.*

192. Leaves have, under particular circumstances, the power of producing leaf-buds from their margin (154); *Ex.* Bryophyllum, Malaxis paludosa, and proliferous Ferns.

VII. HAIRS.

193. Hairs are minute expansions of transparent cellular tissue proceeding from the surface of plants. They are of two kinds, lymphatic and secreting.

194. Lymphatic hairs are formed by *vesicles of* cellular tissue placed end to

end, and not varying much in dimensions.

195. *Secreting* hairs are formed by vesicles of cellular tissue placed end to end, and sensibly distended at the apex or base into receptacles of fluid.

196. Lymphatic hairs are for the protection of the surface on which they are placed, and for the control of evaporation through the stomata (44). They always proceed from the veins, while the stomata occupy the interjacent parenchyma.

197. Secreting hairs are receptacles of the fluid peculiar to certain species of plants, such as the fragrant volatile oil of the sweet briar, and the acrid colourless secretion of the nettle.

VIII. FOOD AND SECRETIONS.

198. Plants are nourished by the absorption of food from the earth, in consequence of which they grow, and produce their peculiar secretions.

199. The growth of plants is very

rapid; that of the leaves is such that they often acquire six or seven times their original weight per hour.

200. The food of plants consists of water, holding various substances in solution. The roots have the power of separating these substances, and selecting such only as are congenial to the nature of the species.

201. As soon as it is absorbed, it begins to ascend into the stem.

202. The ascending fluid is called *sap*; it consists chiefly of water, mucilage, and sugar, mixed with a small quantity of such peculiar secretions of the plant as it may dissolve in its course. It does not alter its nature materially until it is discharged into the leaves.

203. It is put in motion by the newly developing leaf-buds, which, by constantly consuming the sap that is near them, attract it upwards from the roots as it is required. Therefore, the movement of *the sap is the* effect, and not the cause,

of the growth of plants. It depends upon a vital irritability, and is independent of mechanical causes.

204. This *irritability* is indicated not only by the motion of the sap, but by several other phenomena of vegetation; such as,

a. The elasticity with which the stamens sometimes spring up when touched, and the sudden collapsion of many leaves when stimulated.

b. The apparently spontaneous oscillation of the labellum of some Orchideous plants.

c. The expansion of flowers and leaves under the stimulus of light, and the collapsion of them when light is withdrawn. This phenomenon in leaves is called the *sleep of plants.*

d. By the effects of mineral and vegetable poisons being the same upon plants as upon animals. Mineral poisons kill by inflammation and corrosion; vegetable *poisons* by the destruction of irritability.

205. After the sap has been distributed through the veins of the leaves, it becomes exposed to the influence of air and light, and undergoes peculiar chemical changes. In this state it is called the *proper juice.*

206. When the proper juice has been once formed, it flows back along the lower stratum of veins, and descends towards the roots, passing off horizontally into the centre of the stem.

207. Hence the great importance of leaves to plants, and the necessity of exposing them to the full influence of light and air, for the purpose of securing a due execution of their natural functions.

208. Hence also the impropriety of mutilating plants by the destruction of their leaves.

209. In Exogenous plants (80) the upward course of the fluids is through the alburnum, their downward passage through the bark, and their horizontal diffusion takes place by the medullary rays.

210. Hence the peculiar principles of such plants are to be sought either in the bark or the heart-wood (100), not in the alburnum (101).

211. As they are the result of the growth of a plant, they will be found more abundantly in annual plants at the end than at the commencement of their growth.

212. In Endogenous plants (80) it is probable that the upward and horizontal course of the fluids is through the cellular tissue, and that the downward passage takes place through the bundles of vascular tissue.

213. The precise direction of the sap in Cellular plants (80) is unknown.

214. Besides mucilage, water, and sugar, plants contain several other principles either proximate or accessory.

215. The proximate principles are formed by the vital powers of the plant acting, in conjunction with air and light, upon the fluids introduced into its system.

216. Many accessory or foreign principles are also found in plants, such as silex, phosphate of lime, phosphorus, &c.

217. As it has been ascertained, by experiment, that these are formed in plants the aliment of which did not contain them, it is inferred that the presence of such principles also depends upon the operation of the vital powers of vegetation.

218. The most important chemical phenomenon connected with the growth of plants, is the property possessed by their leaves, or green parts, of absorbing oxygen and parting with carbonic acid gas in the dark; and of parting with their oxygen under the influence of the sun.

219. The alternate action of this phenomenon is supposed to cause, in conjunction with the peculiar vital powers of particular species, all the variety of proximate and foreign principles found in vegetables.

220. *No* plants can long exist in which *an alternate* absorption and expulsion

of oxygen does not take place, except Fungi.

221. The expulsion of oxygen is determined by the quantity of light to which a plant is exposed. Light causes the decomposition of the carbonic acid gas, and the accumulation of solid matter.

222. Hence, if a plant is exposed to too strong a light, it perishes, from the excessive expulsion of oxygen.

223. And if it is not exposed to the influence of light, it dies from the accumulation of that principle.

224. If there is too great an accumulation of oxygen, an attempt will always be made by a plant to reach the light, for the purpose of parting with the superfluity; as in seeds, which, in germination, shoot from darkness into light.

225. If this cannot be effected, *etiolation* first takes place, which is caused by the accumulation of oxygen, and the consequent non-decomposition of carbon; and *death* succeeds.

226. Seeds will not germinate in the light, because light decomposes their carbonic acid gas, expels the oxygen, and fixes the carbon, whence all the parts become hardened.

IX. FLOWER-BUDS.

227. The FLOWER-BUD (143) consists of imbricated, rudimentary, or metamorphosed leaves, the external or inferior of which are usually alternate, and the internal or superior always verticillate, or opposite; the latter are called *floral envelopes* and *sexes*.

228. As every flower-bud proceeds from the axilla of a leaf, either fully developed or rudimentary, it therefore occupies exactly the same position with respect to the leaf as a leaf-bud.

229. The leaf from the axilla of which a flower-bud arises, is called a *bractea*, or *floral leaf*; and all rudimentary leaves, of what size or colour soever, which appear *on the* peduncle between the floral *leaf and the* calyx, are called bracteolæ.

230. But in common language, botanists constantly confound these two kinds, which are, nevertheless, essentially distinct.

231. Although the buds in the axillæ of bracteæ are often not developed, yet they have the same power of developement as those in the axillæ of leaves; they are generally flower-buds, very rarely leaf-buds.

232. When a single bractea is rolled together, highly developed, and coloured, and is placed at the base of the form of inflorescence called a spadix (259), it is named *spatha; Ex.* Arum.

233. When several bracteæ are verticillate or densely imbricated around the base of the forms of inflorescence called the umbel, or capitulum (261), they receive the name of *involucrum; Ex.* Carrot, Daisy.

234. When the bracteæ of an involucrum form a single whorl, and cohere by their margins, it is impossible to distinguish them from the calyx by any othe

mark than by their position, and by their usually surrounding more flowers than one.

235. The minute or colourless bracteæ at the base of the florets of a capitulum (261) are called *paleæ*.

236. Small imbricated bracteæ are often called *scales*.

237. Bracteæ, when placed immediately below the sexes, as in apetalous flowers, are only distinguished from the calyx by being alternate with each other, and not verticillate; hence the *glumes* and *paleæ* of grasses are bracteæ and not calyx.

238. The axis of the flower-bud in its natural state does not elongate beyond those upper series of metamorphosed leaves which constitute the sexes.

239. The elongation of its axis, from the point of its connexion with the stem, as far as the floral envelopes, is called the *peduncle*.

240. When several peduncles spring from the axis at short distances from

each other, the axis receives the name of *rachis*, and the peduncles themselves are called *pedicels*.

241. There is never more than one flower to each peduncle, strictly speaking; therefore, when we speak of a two-flowered peduncle, we only mean that two flowers, each having its peculiar pedicel, terminate the axis, which is then considered a peduncle common to each pedicel.

242. Every flower, with its peduncle and bracteolæ, being the developement of a flower-bud, and flower-buds being altogether analogous to leaf-buds, it follows, as a corollary, that every flower, with its peduncle and bracteolæ, is a metamorphosed branch.

243. And further, the flowers being abortive branches, whatever the laws are of the arrangement of branches with respect to each other, the same will be the laws of the arrangement of flowers with *respect to* each other.

244. The flower-buds, however, being much less subject to abortion than leaf-buds, flowers are more symmetrically disposed than branches, and appear to possess their own peculiar order of developement.

245. As flower-buds can only develope from the axilla of a bractea, it follows, that while a pedicel without bracteæ can never accidentally produce other flowers, any one-flowered pedicel, on which bracteæ are present, can, and frequently does, bear several flowers.

246. In consequence of a flower and its peduncle being a branch in a particular state, the rudimentary or metamorphosed leaves which constitute bracteæ, floral envelopes, and sexes, are subject to exactly the same laws of arrangement as regularly formed leaves.

247. The modes in which the flower-buds are arranged are called *forms of inflorescence;* and the order in which they unfold is called the *order of expansion.*

X. INFLORESCENCE.

248. Inflorescence is the ramification of that part of the plant intended for reproduction by seed.

249. The greater developement of some forms of inflorescence than of others, is owing to the greater power one plant possesses than another of developing buds, latent in the axillæ of the bracteæ.

250. A flower-bud may either develope into a single flower, or may follow the laws of increase of leaf-buds, and give birth to many other flower-buds.

251. In consequence of flower-buds obeying the laws which regulate leaf-buds, all forms of inflorescence must, of necessity, be axillary.

252. Those forms which are called *opposite the leaves, extra-axillary, petiolar,* or, *epiphyllous,* and even the *terminal* itself, are mere modifications of the axillary.

253. The kinds of inflorescence which

botanists more particularly distinguish are the following : —

254. When no elongation of the general axis of a plant takes place beyond the developement of a flower-bud, the flower becomes what is called *terminal* and *solitary; Ex.* Pæony.

255. When a single flower-bud unfolds in the axilla of a leaf, and the general axis continues to elongate, and the leaf undergoes no sensible diminution of size, the flower which is developed is said to be *solitary* and *axillary.*

256. If all the buds of a newly formed elongated branch develope as flower-buds, and at the same time produce peduncles, a *raceme* is formed.

257. If buds, under the same circumstances, develope without forming peduncles, a *spike* is produced.

258. Hence the only difference between a spike and raceme is, that in the former the flowers are sessile, and in the latter stalked.

259. A *spadix* differs from a spike in nothing more than in the flowers being packed close together upon a succulent axis, which is enveloped in a spatha (232).

260. An *amentum* is a spike the bracteæ of which are all of equal size, and closely imbricated, and which is articulated with the stem.

261. When a bud produces flower-buds, with little elongation of its own axis, either a *capitulum* or an *umbel* is produced.

262. The capitulum bears the same relation to the umbel as the spike to the raceme; that is to say, they differ in the flower-buds of the capitulum being sessile, and of the umbel having pedicels.

263. The dilated depressed axis of the capitulum is called the *receptacle*.

264. A raceme, the lowest flowers of which have long pedicels, and the uppermost short ones, is a *corymb*.

265. A *panicle* is a raceme, the flower-buds of which have, in elongating, developed other flower-buds.

266. A panicle the middle branches of which are longer than those of the base or apex, is called a *thyrsus*.

267. A panicle the elongation of all the ramifications of which is arrested, so that it assumes the appearance of an umbel, is called a *cyme*.

268. In all modes of inflorescence which proceed from the buds of a single branch, the axis of which is either elongated or not, the flowers expand first at the base of the inflorescence, and last at the summit. This kind of expansion is called *centripetal*.

269. When the uppermost or central flowers open first, and those at the base or the circumference last, the expansion is called *centrifugal*.

270. The centripetal order of expansion always indicates that the inflorescence proceeds from the developement of the buds of a single branch.

271. When inflorescence is the result of the developement of several branches,

each particular branch follows the centripetal law of expansion, but the whole mass of inflorescence the centrifugal.

272. This arises from the partial centripetal developement commencing among the upper extremities of the inflorescence instead of among the lower.

273. Consequently, this difference of expansion will indicate whether a particular form of inflorescence proceeds from the developement of the buds of a single branch, when it is called *simple*, or not, when it is called *compound*.

274. Whenever the order of expansion is centripetal, the inflorescence is to be understood as simple; when it is centrifugal, it is compound, although in appearance simple. This difference is often of great importance.

275. When the order of expansion is irregular, it indicates that the mode of developement of the flowers is irregular also, either on account of abortion or other causes.

276. Sometimes all the flowers of the inflorescence are abortive, and the ramifications, or the axis itself, assume a twisted or spiral direction; when this happens a *tendril* is formed; *Ex.* the Vine.

XI. FLORAL ENVELOPES.

277. The Floral Envelopes are the parts which immediately surround the sexual organs.

278. They are formed of one or more whorls of bracteæ, and are therefore modified leaves (229).

279. In anatomical structure they do not essentially differ from the leaves, farther than is necessarily consequent upon the peculiar modifications of size or developement to which they are subject.

280. When the floral envelopes consist of but one whorl of leaves, they are called *calyx*.

281. When two or more whorls are developed, the outer is called calyx, the inner *corolla*.

282. There is no other essential difference between the calyx and corolla. Therefore, when a plant has but one floral envelope, that one is calyx, whatever may be its colour or degree of developement.

283. It is necessary, however, to be aware, that sometimes the calyx is reduced to a mere rim, either in consequence of lateral compression, as in the *pappus* (*aigrette, Fr.*) of many Compositæ, or from other unknown causes, as in some Acanthaceæ.

284. If the floral envelopes are of such a nature that it is not obvious whether they consist of both calyx and corolla, or of calyx only, they receive the name of *perianthium* or *perigonium*.

285. Plants have frequently no floral envelopes; in that case, flowers are said to be *naked* or *achlamydeous*.

286. When the floral envelopes are deciduous, they fall from the peduncle, as leaves from a branch, by means of an articulation; if they are persistent; it is *because* no articulation takes place.

287. When the margins of floral envelopes are united, the part where the union has taken place is called the *tube*, and that where they are separate is named the *limb*. It frequently happens that in the calyx an articulation forms between the limb and the tube.

288. Botanists generally consider that the tube of the calyx is invariably formed by the union of the margins of the sepals. It is, however, probable, that it is in some cases a mere dilatation and expansion of the pedicel itself, as in Eschscholtzia.

289. When the calyx and corolla are readily distinguishable from each other, they exhibit the following peculiarities:—

290. The *calyx* consists of two or more divisions, usually green, called *sepals*, which are either distinct, when a calyx is said to be *polysepalous*, or which unite by their margins in a greater or less degree, when it is called *monosepalous* or *monophyllous*.

291. The *corolla* consists of two or

more divisions, called *petals*, usually of some bright colour, different from that of the sepals, than which they are frequently more developed. When the petals are distinct a corolla is said to be *polypetalous;* when they are united by their margins, it is called *monopetalous*.

292. If the union of the petals or sepals takes place in one or two parcels, the corolla or calyx are said to be one or two-lipped. These lips are always anterior and posterior with respect to the axis of inflorescence, and never right and left.

293. If the sepals or petals are of unequal size, or unite in unequal degrees, the calyx or corolla is said to be irregular.

294. When the petals are so arranged that of five the uppermost is dilated, the two lateral ones contracted and parallel with each other, and the two lower also contracted, parallel with each other, and coherent by their anterior margins, a flower is said to be *papilionaceous*.

295. When a petal tapers conspicuously

towards the base it is said to be *unguiculate;* its lower part is called the *unguis,* its upper the *limb.* The former is analogous to the petiole, the latter to the lamina of a leaf.

296. The petals always alternate with the sepals, a necessary consequence of their following the laws of developement of leaves.

297. If at any time the petals arise from before the sepals, such a circumstance is due to the abortion of one whorl of petals between the sepals and those petals which are actually developed.

298. As petals always alternate with sepals, the number of each row of either will always be exactly the same. All deviations from this law are either apparent only, in consequence of partial cohesions, or if real, are due to partial abortions.

299. Whatever intervenes between the bracteæ and the stamens belongs to the floral *envelopes,* and is either calyx or

corolla; of which nature are many of the organs vulgarly called *nectaries.*

300. The dilated apex of the pedicel, from which the floral envelopes and stamens arise, is called the *torus* or *receptacle.*

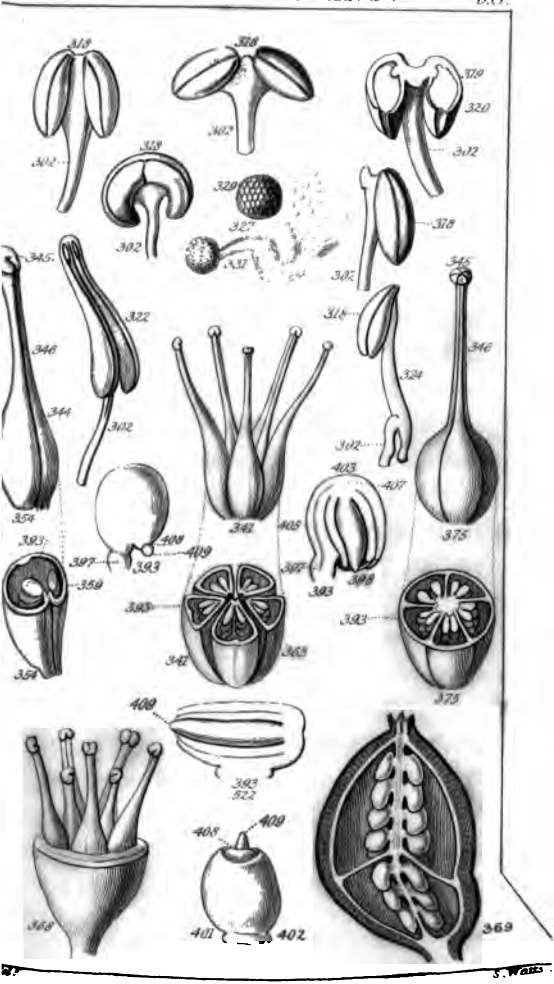
301. The manner in which the floral envelopes are arranged before they expand is called their *æstivation* or *præfloration.*

XII. MALE ORGANS—STAMENS.

302. The whorl of organs immediately within the petals is composed of bodies called *stamens,* which are considered the male apparatus of plants.

303. They consist of a bundle of spiral vessels surrounded by cellular tissue, called the *filament,* terminated by a peculiar arrangement of the cellular tissue, in a case, finally opening and discharging its contents, called the *anther.*

304. **There** are many instances in which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no limits can be traced between the petals and stamens; *Ex.* Nymphæa.

305. In such cases it is found that the limb (295) of the petal contracts, and becomes an anther, while the unguis assumes the state of a filament.

306. Now as there are no limits between the petals and sepals (282), nor between the sepals and bracteæ (278), nor between the bracteæ and leaves (229), it follows that the stamens are also a modification of leaves.

307. And as the limb of a petal is analogous to the lamina, and the unguis (295) to the petiole of a leaf, it also follows that the anther is a modification of the lamina, and the filament of the petiole.

308. The stamens follow the same laws of successive developement as leaves; and consequently, if their arrangement be normal, they will be either equal in number to the petals, and alternate with them, or,

if more numerous, some regular multiple of the petals.

309. If they are twice the number of petals, two whorls are considered to be developed; and so on.

310. If they are equal in number to the petals, and opposite them, it is to be understood that the innermost only of two whorls is developed, the outermost being abortive.

311. All deviations from these laws are due to the abortion of some part of the stamens; *Ex.* Lamium, Hippuris.

312. When the stamens do not contract any union with the sides of the calyx, they are *hypogynous; Ex.* Ranunculus.

313. When they contract adhesion with the sides of the calyx, they become *perigynous; Ex.* Rose.

314. If they are united both with the surface of the calyx and of the ovarium, they are *epigynous*; *Ex.* Umbelliferæ.

315. The *filaments* (303) are either distinct or united by their margins. If they are united in one tube, they are called *monadelphous; Ex.* Malva: if in two parcels, *diadelphous; Ex.* Pea: if in several, *polyadelphous; Ex.* Hypericum.

316. When they are united in a solid body, along with the style, they form what is called a *column*, and are said to be *gynandrous*.

317. The filament is not essential to a stamen, and is, in fact, often absent.

318. The *anther* is the limb of the stamen, forming within its substance, and finally emitting, a matter called *pollen*.

319. The two sides of the anther are called its *lobes;* and the solid substance which connects them, and which is in fact a continuation of the filament, as the midrib of a leaf is of the petiole, is named the *connectivum*.

320. The cavities of the anther containing the pollen are the *cells*, and the

place by which the pollen is emitted is the point or line of *dehiscence;* the membranous sides of the anther are named the *valves.*

321. Dehiscence usually takes place along a line, which may be considered to indicate the margin of the limb out of which the anther is formed; *Ex.* Rose.

322. Sometimes a portion only of this line opens, and then the anther is said to dehisce by *pores; Ex.* Azalea.

323. If the line of dehiscence occupies both margins of the connectivum, and not the centre of the lobes, the anther opens by one valve instead of two, which is then hinged by its upper edge; *Ex.* Berberry.

324. The cells of the anther are usually two in number: sometimes they are four; *Ex.* Tetratheca: rarely one; *Ex.* Epacris: and still more rarely several; *Ex.* Rafflesia.

325. The number of cells appears to *be determined* by no certain rule.

326. The anthers frequently grow to-

gether by their margins; *Ex.* Compositæ. Such anthers are called *syngenesious.*

327. The *Pollen* is formed by a peculiar modification of the cellules of the parenchyma of the anther.

328. That part of the central cellular tissue of the anther which is not converted into pollen, serves to connect the granules together, in the form of a tenacious fibrous web; *Ex.* Œnothera, Orchis.

329. Pollen consists of vesicles or granules of cellular tissue, enclosing a mucous substance, in which an infinite number of exceedingly minute molecular bodies having a power of active motion, is contained.

330. The function of the pollen is to vivify the ovula (344).

331. For this purpose a granule of pollen which has fallen upon the stigma bursts, and emits the mucus it contains, along with the active molecules floating in it.

332. This mucus passes down the intercellular passages of the stigma and style,

and is finally conducted into the ovulum, through its foramen (408).

333. In plants the ovula of which have no pericarpial covering (425), as Coniferæ, the molecules of the pollen are communicated to the ovulum without the intervention of any form of tissue.

334. Each molecule produces one embryo, and usually but one is developed in each ovulum; but sometimes two or more accidentally develope, and then a seed contains several embryos, as the Orange, the Onion, the Mistletoe.

XIII. DISK.

335. Whatever intervenes between the stamens and the pistillum receives the general name of disk.

336. It usually consists of an annular elevation, encompassing the base of the ovarium, when it is sometimes called the *cup; Ex.* Pæony.

337. Or it appears in the form of a *glandular lining* of the tube of the calyx;

Ex. Rose: or of tooth-like, hypogynous (312), processes; *Ex.* Gesneria, Cruciferæ: or of a fleshy mass, upon which the ovaria appear to be seated; *Ex.* Lamium.

338. It is certain that the disk is sometimes a non-developement of an inner row or rows of stamens, as is proved by the Moutan Pæony; and it is probable that such is generally its nature.

339. But it is also probable that the disk is sometimes a mere cellular expansion of the torus (300), as in Nelumbium.

340. The disk is one of the parts which Linnæan botanists call *nectary*.

XIV. PISTILLUM—FEMALE ORGANS.

341. The organ which occupies the centre of a flower, within the stamens, and disk, if the latter be present, is called the *pistillum*.

342. It is the female apparatus of flowering plants.

343. It is distinguished into three

parts, viz. the *ovarium*, the *style*, and th *stigma*.

344. The OVARIUM is a hollow cas enclosing *ovula* (354). It contains or or more cavities, called *cells*.

345. The STIGMA is the upper extr mity of the pistillum.

346. The STYLE is the part that co nects the ovarium and stigma.

347. The style is frequently absent, ar is no more essential to a pistillum than petiole to a leaf, or a filament to an anthe

348. Sometimes the style is thin, fla and membranous, and assumes the for of a petal, as in Iris.

349. The style is either articulated wi the ovarium, or continuous with it. usually proceeds directly from the ap of the ovarium; but in some cases aris from the side, or even the base of th organ; *Ex.* Alchemilla, Chrysobalaneæ.

350. Nothing is, properly speakin stigma, except the secreting surface of tl *style.* Nevertheless, the name is oft

inaccurately applied to mere divisions of the style, as in Labiatæ; or to the hairy surface of undivided styles, as in Lathyrus.

351. Sometimes the stigmas grow to the face of the anthers, which form themselves into a solid mass; *Ex.* Asclepias. In this case the styles remain separate.

352. The pistillum is either the modification of a single leaf, or of one or more whorls of modified leaves.

353. Such modified leaves are called *carpella.*

354. A CARPELLUM is formed by a folded leaf, the upper surface of which is turned inwards, the lower outwards, and the margins of which develope one or a greater number of buds, which are the *ovula.*

355. When the carpella are stalked, they are said to be seated upon a *thecaphore,* or *gynophore; Ex.* Cleome, Passiflora. Their stalk is analogous to the petiole of a leaf.

356. The ovarium is the lamina of the leaf.

357. The style is an elongation of the midrib (174).

358. The stigma is the denuded, secreting, humid apex of the midrib.

359. Where the margins of the folded leaf, out of which the carpellum is formed, meet and unite, a copious developement of cellular tissue takes place, forming what is called the *placenta*.

360. Every placenta is therefore composed of two parts, one of which belongs to one margin of the carpellum, and one to the other.

361. As the carpella are modified leaves, they necessarily obey the laws of arrangement of leaves, and are therefore developed round a common axis.

362. And as they are leaves folded inwards, their margins are necessarily turned towards the axis. The placenta, therefore, being formed by the union of

those margins, will be invariably next the axis.

363. So that if a whorl of several carpella unite and constitute a pistillum, the placentæ of that pistillum will be all in the axis.

364. The normal position of the carpella is alternate with the innermost row of stamens, to which they are also equal in number; but this symmetry of arrangement is constantly destroyed by the abortion or non-developement of part of the carpella.

365. The carpella often occupy several whorls, in which case they are usually distinct from each other; *Ex.* Ranunculus, Fragaria, Rosa.

366. Sometimes, notwithstanding their occupying more than one whorl, they all unite in a single pistillum; *ex.* Nicotiana multivalvis, Monstrous Citrons. In these cases the placentæ of the innermost whorl of carpella occupy the axis, while those of the exterior carpella are united with the backs of the inner ones, as

must necessarily happen in consequence of the invariable direction of the placentæ towards the axis.

367. When the carpella are arranged round a convex receptacle (263), the exterior ones will be lowest; *Ex.* Fragaria.

368. But if they occupy the surface of a tube, or are placed upon a concave receptacle, the exterior ones will be uppermost; *Ex.* Rosa.

369. This law will explain the structure of some anomalous pistilla, in which the carpella are united into a confused mass; *Ex.* the Pomegranate.

370. Notwithstanding the formation of the placenta out of the two united margins of a leaf, it often does not indicate any trace of such an origin; but, in consequence of non-developement, is sometimes reduced to a single point, bearing a single ovulum.

371. When the placentiferous margin is fully and regularly developed, it occu*pies a line* running down the inside of the

cavity of a carpellum, and bears two distinct rows of ovula.

372. If that part of the margin which is placentiferous is so small as to bear but a very few ovula at or towards the upper part of the line of union, the ovula will hang downwards within the cavity of the carpellum, and be either *pendulous* or *suspended.*

373. And if the placentiferous part of the margin be only at the lower part of the line of union, the ovula will take a direction upwards into the cavity, and be either *erect* or *ascending.*

374. Whenever two carpella are developed, they are invariably opposite each other, and never side by side. This happens in consequence of the law of alternate opposition of leaves (160).

375. When carpella unite, those parts of their sides which are contiguous grow together, and form partitions between the cavities of the carpella.

384. *Spurious dissepiments* derive th origin from various causes, and may ha either a vertical or horizontal position.

385. When they are horizontal th are called *phragmata*, and are formed the distension of the placenta; *Ex.* C thartocarpus Fistula.

386. If vertical, they either are proj tions from the back of the carpellum, as Amelanchier and Thespesia; or they a caused by modifications of the placent as in Martynia, Didymocarpus, and Ci ciferæ.

387. Sometimes the apex of the pedi extends beyond the base of the carpel rising up between them, and either for ing an adhesion with the styles, as Geranium, or a central distinct axis, as Euphorbia.

388. This elongation of the apex of t pedicel is more apparent in the fruit th in the pistillum. It is analogous to t cellular apex of the spadix (259) of Aru

389. The styles of different carpe

frequently grow together into a solid cylinder; *Ex.* Lilium. There are various degrees of union between the styles.

390. The style is incorrectly said to be divided in different ways, in consequence of this adhesion.

391. If the *ovarium* adheres to the sides of the calyx it is called *inferior*, and the *calyx* is said to be *superior*; *Ex.* Apple.

392. If it contracts no adhesion with the sides of the calyx it is called *superior*, and the *calyx inferior*.

XV. OVULUM.

393. The Ovulum is a body borne by the placenta (359), and destined to become a seed (469).

394. It is to the carpellum (353) what the marginal buds are to leaves (154).

395. It does not, however, appear to bear any other analogy to a bud than what is indicated by its position.

396. The ovulum is usually enclosed

within an ovarium (344); but in Coniferæ and Cycadeæ it is destitute of any covering, and is exposed, naked, to the influence of the pollen.

397. It is either sessile, or attached by a little stalk called the *funiculus*, or *podosperm*. The point of union of the funiculus and ovulum is the *base* of the latter, and the opposite extremity is its *apex*.

398. It consists of two sacs, one enclosed within the other, and of a *nucleus* within the sacs.

399. These sacs are called the *primine* and *secundine*.

400. The primine, secundine, and nucleus, are all connected with each other by a perfect continuity of tissue, at some point of their surface.

401. When the parts of the ovulum undergo no alteration of position during their growth, the two sacs and the nucleus re all connected at the base (397) of the ovulum.

402. And then the base of the nucleus

and that of the ovulum are in immediate connexion with each other.

403. But the relative position of the sacs and the base of the ovulum are often entirely altered during the growth of the latter, so that it frequently happens that the point of union of the sacs and the nucleus is at the apex (397) of the ovulum.

404. And then the base of the nucleus is at the apex of the ovulum.

405. In such cases, a vascular connexion is maintained between the base of the ovulum and the base of the nucleus, by means of a bundle of vessels called a *raphe*.

406. The normal position of this raphe is on the side of the ovulum, next the placenta.

407. The expansion of the raphe, where it communicates with the base of the nucleus, gives rise to the part of the seed called the *chalaza* (491).

408. The mouths of the primine and secundine usually contract into a small

aperture called the *foramen* of the ovulum, or the *exostome*.

409. The apex of the nucleus is always applied to this foramen.

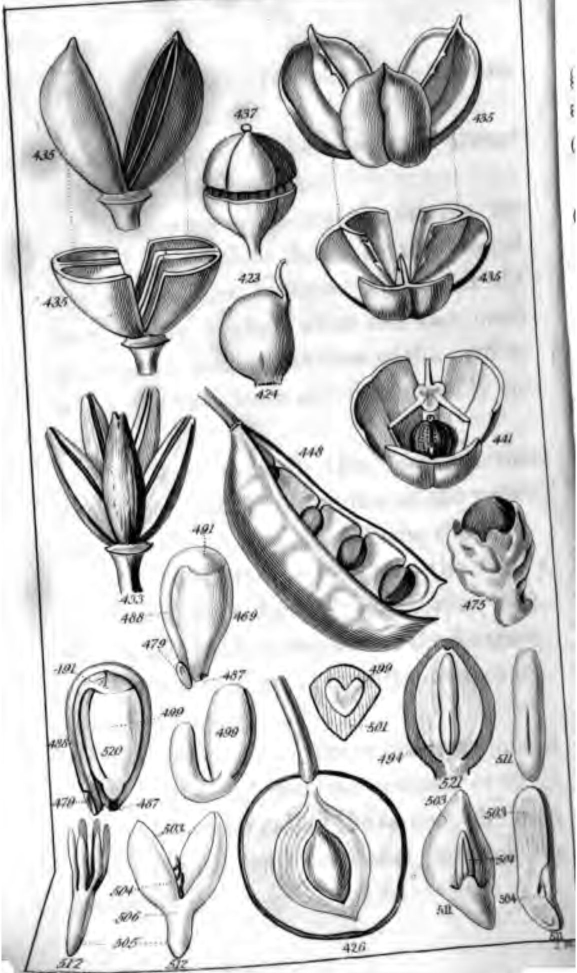
410. In consequence of the relation the base of the nucleus bears to the base of the ovulum, the foramen will be at the apex of the ovulum when the two bases correspond, and at the base of the ovulum when the two bases are diametrically opposite.

411. It is through this foramen that the impregnating molecules of the pollen are introduced into the nucleus (332).

412. The foramen indicates the future position of the radicle of the embryo (492); the radicle being always next the foramen. This is a fact of great importance in practical Botany.

413. From some recent observations, it appears that the nucleus consists of three coats; the outer called the *tercine*, the next the *quartine*, and the most interior the *quintine*.

FRUIT & SEED.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414. But these are not always distinguishable, and part of them is usually absorbed during the advance of the ovulum to the state of a seed.

415. The tercine and quartine are finally converted into albumen (494); the quintine becomes the *sac of the embryo* (501), whenever that sac is distinguishable; *Ex.* Nymphæa.

416. The nucleus contains a pulpy mass called the *liquor amnios*, which is supposed to be the substance from which the embryo absorbs its nutriment during its growth.

XVI. FRUIT.

417. The FRUIT, in the strictest sense of the word, is the pistillum arrived at maturity. But the term is also applied to the pistillum and floral envelopes taken together, when they are all united in one uniform mass.

418. Hence, whatever is the structure of the pistillum, the same should be the structure of the fruit.

419. But in the course of the advance of the pistillum towards maturity, many alterations take place, in consequence of abortion, non-developement, obliteration, and union of parts.

420. Whenever the fruit contains any thing at variance with the laws that govern the structure of the pistillum, the latter should be examined for the purpose of elucidation.

421. Sometimes a pistillum with several cells produces a fruit with but one; *Ex.* the Hazel-nut and Cocoa-nut. This arises from the obliteration of part of the cells.

422. Or a pistillum, consisting of one or two cells, changes to a fruit having several: the cause of this is a division and doubling of the placentary divisions; *Ex.* Martynia: or the expansion of portions of the placenta; *Ex.* Cathartocarpus Fistula.

423. As the fruit is the maturation of *the pis*tillum, it ought to indicate upon

its surface some traces of a style: and this is true in all cases, except Cycadeæ and Coniferæ, which have no ovarium.

424. Hence the grains of corn, and many other bodies that resemble seeds, having traces of the remains of a style, cannot be seeds, but are minute fruits.

425. That part which was the ovarium in the pistillum becomes the pericarpium in the fruit.

426. The PERICARPIUM consists of three parts, the outer coating called the *epicarp*, the inner lining called the *endocarp*, or *putamen*, and the intermediate substance named the *sarcocarp*.

427. Sometimes these three parts are all readily distinguished; *Ex.* the Peach: frequently they form one uniform substance; *Ex.* a Nut.

428. The *base* of the fruit is the part where it is joined to the peduncle. The *apex* is where the remains of the style are found.

429. The axis of the fruit is often

called the *columella;* the space where two carpella unite is named the *commissure.*

430. All fruits which are mere modifications of a single carpellary leaf (354) have always a suture corresponding with the junction of the margins, or with the placentæ, and often another corresponding with the midrib of the carpellary leaf: the former is called the *ventral,* the latter the *dorsal suture.*

431. If the pericarp neither splits nor opens when ripe, it is said to be *indehiscent;* if it does split or open, it is said to *dehisce,* or to be *dehiscent;* and the pieces into which it splits are called the *valves.*

432. The dehiscence of the pericarp takes place in different ways.

433. If it takes place longitudinally, or vertically, so that the line of dehiscence corresponds with the junction of the carpella, the dissepiments are divided, *the cells* remain closed at the back, and

the *dehiscence* is called *septicidal; Ex.* Rhododendron.

434. Formerly, botanists said that in this kind of dehiscence the *valves were alternate with the dissepiment;* or, that the *valves had their margin turned inwards.*

435. If it takes place vertically, so that the line of dehiscence corresponds with the dorsal suture (430), the dissepiments remain united, the cells are opened at their back, and the dehiscence is called *loculicidal; Ex.* Lilac, Lily.

436. Formerly it was said that in this kind of dehiscence *the dissepiments were opposite the valves.*

437. When a separation in the pericarpium takes place across the cells horizontally, the dehiscence is *transverse; Ex.* Anagallis.

438. If the dehiscence is effected by partial openings of the pericarpium, it is said to take place by pores; *Ex.* Poppy.

439. Sometimes the cells remain closed, separating from the axis, formed by the

extension of the peduncle (387); *Ex.* Umbelliferæ, Euphorbia.

440. Or the cells open and separate from the axis, which is formed by a cohesion of the placentæ which separate from the dissepiments; *Ex.* Rhododendron.

441. Sometimes the dissepiments cohere at the axis, and separate from the valves (431) or back of the carpella; *Ex.* Convolvulus.

442. All fruits are either *simple* or *multiple.*

443. Simple fruits proceed from a single flower; *Ex.* Pæony, Apple, Nut, Strawberry.

444. Multiple fruits are formed out of several flowers; *Ex.* Fir, Pine-Apple, Fig. They are masses of inflorescence in a state of adhesion.

445. Simple fruits are either the maturation of a single carpellum (354), or of a pistillum formed by the union of *several* carpella (363).

446. Of fruit formed of a single carpellum, the most important are the Follicle (447), Legume (448), Drupe (451), Akenium (452), Caryopsis (454), and Utricle (455).

447. The *Follicle* is a carpellum dehiscing by the ventral suture, and having no dorsal suture; *Ex.* Pæony.

448. The *Legume* is a carpellum having both a ventral and dorsal suture, and dehiscing by both, either, or neither; *Ex.* Pea.

449. The two sutures of a legume sometimes form what is called a *replum*; *Ex.* Carmichælia.

450. When articulations take place across the legumen, and it falls into several pieces, it is said to be lomentaceous; *Ex.* Ornithopus.

451. The *Drupe* differs from the follicle in being indehiscent, and in its pericarpium having a distinct separation of epicarp (426), sarcocarp, and endocarp; *Ex.* a. Peach.

452. The *Akenium* is an indehiscent, bony, one-seeded pericarpium, which does not contract any degree of adhesion with the integument of the seed; *Ex.* Strawberry.

453. It is a drupe, the pericarp of which does not separate into three layers.

454. The *Caryopsis* is an indehiscent, membranous, one-seeded pericarpium, which adheres firmly to the integument of the seed; *Ex.* Corn.

455. The *Utricle* is a caryopsis, the pericarpium of which has no adhesion with the integuments of the seed; *Ex.* Eleusine, Chenopodium.

456. Of fruit formed of several carpella, the principal are the Capsule (457), Siliqua (458), Nut or Gland (460), Berry (461), Orange (462), Pome (463), and Pepo (464).

457. The *Capsule* is a many-celled, dry, dehiscent pericarpium; *Ex.* Poppy, Lychnis.

458. The *Siliqua* consists of two (or

four?) carpella fastened together, the placentæ of which are parietal, and separate from the valves, remaining in the form of a replum (449), and connected by a membranous expansion; *Ex.* Brassica.

459. When the siliqua is very short, or broader than it is long, it is called a *Silicula.*

460. The *Nut or Gland* is a dry, bony, indehiscent, one-celled fruit, proceeding from a pistillum of three cells, and enclosed in an involucrum called a *cupula; Ex.* the Hazel, Acorn. It is a sort of compound achenium.

461. The *Berry* is a succulent fruit, the seeds of which lose their adhesion when ripe, and lie loose in pulp; *Ex.* a Gooseberry, a Grape.

462. The *Orange* is a berry having a pericarpium separable into an epicarp, an endocarp, and a sarcocarp, and the cells filled with pulpy bags, which are cellular extensions of the sides of the cavity.

463. The *Pome* is a union of two or more inferior carpella, the pericarpium being fleshy, and formed of the floral envelope and ovarium firmly united; *Ex.* an Apple.

464. The *Pepo* is composed of about three carpella, the sides of which do not turn far inwards, nor the margins unite. It is a one-celled, fleshy, indehiscent fruit, with parietal placentæ; *Ex.* Cucumber.

465. The most remarkable modifications of multiple fruits are, the Cone (466), Pine-Apple (467), and Fig (468).

466. The *Cone* is an indurated amentum (260); *Ex.* Pinus. When it is much reduced in size, and its scales firmly cohere, it is called a *Galbulus; Ex.* Thuja.

467. The *Pine-Apple* is a spike of inferior flowers, which all grow together into a fleshy mass.

468. The *Fig* is the fleshy, hollow, dilated apex of a peduncle, within which a number of flowers are arranged, each of *which* contains an achenium.

XVII. SEED.

469. The SEED is the ovulum (393) arrived at maturity.

470. It consists of integuments (482), albumen (494), and embryo (502), and is the result of the reciprocal action of the sexual apparatus.

471. As all seeds are matured ovula, and as all ovula are originally enclosed within an ovarium, it is obvious that *naked seeds* cannot exist.

472. Cycadeæ and Coniferæ are the only exceptions to this (396).

473. But some ovula rupture the ovarium soon after they begin to advance towards the state of seed, and thus become naked seeds; *Ex.* Leontice. Others are imperfectly protected by the ovarium, the carpella not being perfectly closed up; *Ex.* Reseda.

474. The seed proceeds from the placenta (359), to which it is attached by the funiculus (397).

475. Sometimes the funiculus, or the

placenta, expands about the seed into a fleshy body; *Ex.* the *Mace* of a nutmeg, Euonymus. This expansion is named *arillus.*

476. It is never developed until after the vivification of the ovulum, and must not be confounded with tumours or dilatations of the integument of the seed.

477. Sometimes there are tumours of the testa near the hilum or at the opposite end; such are called *Strophiolæ* or *Caruncula.*

478. The precise nature of these is unknown; sometimes they are dilatations of the chalaza; *Ex.* Crocus: or they are caused by a fungous state of the lips of the foramen; *Ex.* Ricinus: or they arise from unknown causes.

479. The scar, which indicates the union of the seed with the placenta, is called the *hilum* or *umbilicus.*

480. The hilum represents the *base* of the seed. The *apex* is determined by the point where the vessels or tissue of the *integuments* concentrate.

481. Hence, in curved seeds the apex

and base are frequently contiguous; *Ex.* Mignonette.

482. The integuments are called collectively *testa*, and consist of membranes, resulting from the sacs of the ovulum (399).

483. Sometimes the testa is covered by hair-like expansions of its whole surface; as in the Cotton; or these hairs occupy one or both ends, when they constitute what is called the *coma*. This must not be confounded with the pappus (283).

484. Some of these occasionally grow together, so that seeds are sometimes apparently enclosed in but one or two membranes.

485. In the seed these membranes are called by various names, of which the most frequently used are *spermoderm* or *testa* for the primine; *mesosperm*, for the secundine; and *endopleura* for the other.

486. All that existed in the sacs of the embryo is to be found in the integuments of the seed, but in a more developed state.

487. The mouth of the foramen (408) is often distinctly visible, and is named the *micropyle*. *Ex.* Pea.

488. The *raphe* (405) occupies one side of the seed in all cases in which it pre-existed in the primine; but it frequently becomes much ramified.

489. The raphe is in no way connected with impregnation; its functions being apparently confined to maintaining a vascular connexion between the placenta and the base of the nucleus, for the purpose of nourishing the latter.

490. Spiral vessels are found in the raphe and its ramifications.

491. Where the vessels of the raphe expand into the mesosperm (485), the *chalaza* (407) appears as a discoloured thickening of the integuments.

492. The micropyle always indicates the point in the circumference of a seed towards which the radicle (412) points.

493. And the chalaza is as constant an *indication*, when it is present, of the situ-

ation of the cotyledons (503); it being always at that part of the circumference opposite the radicle.

494. Between the integuments and the embryo of some plants lies a substance called the *albumen* or *perisperm*.

495. It consists of a peculiar substance deposited during the growth of the ovulum among the cellular tissue of the nucleus (398).

496. Care must be taken not to confound a thickening of the endopleura (485), with the real albumen; *Ex.* Cathartocarpus Fistula. It is probable that this is often done by botanists, especially in regard to plants belonging to tribes usually destitute of albumen.

497. When the cellular tissue of the nucleus combines with the deposited matter so completely as to form together but one substance, the albumen is called solid. *Ex.* Wheat, Euphorbia. When a portion of the tissue remains unconverted, the

albumen is *ruminated*. *Ex.* Anona, Nutmeg.

498. Albumen is usually wholesome, and may be frequently eaten with impunity in the most dangerous tribes. *Ex.* Euphorbiaceæ.

499. The organised body that lies within the seed, and for the purpose of protecting and nourishing which the seed was created, is the *Embryo*.

500. The embryo was originally included within the most interior membrane of the ovulum.

501. This is usually absorbed or obliterated during the advance of the embryo to maturity; but it sometimes remains surrounding the ripe embryo, in the form of a sac, which is called *Vitellus*. *Ex.* Saururus, Piper.

502. The embryo consists of the cotyledons (503), the radicle (505), the plumula (504), and the neck (506).

503. The *cotyledons* represent the undeveloped leaves.

504. The *plumula* or *gemmula*, is the nascent ascending axis (60).

505. The *radicle* is the rudiment of the descending axis (60).

506. The *neck* (Collet, *Fr.*) is the line of separation between the radicle and the cotyledons.

507. The space that intervenes between the neck and the base of the cotyledons is called the *cauliculus* (Tigelle, Fr.)

508. The embryo is usually solitary in the seed, but occasionally there are two or several (334).

509. When several embryos are produced within a single seed, it sometimes happens that two of these embryos grow together, in which case a production analogous to animal dicephalous monsters is formed.

510. The number of cotyledons varies from one to several. The most common number is either one or two. In the latter case, they are always directly opposite each other.

511. Plants that have but one cotyle-

don, or if two, then the cotyledons alternate with each other, are called MONOCOTYLEDONOUS.

512. Plants that have two opposite each other, or a greater number placed in a whorl, are called DICOTYLEDONOUS.

513. Endogenous plants are monocotyledonous.

514. Exogenous plants are dicotyledonous.

515. Plants that have no cotyledons are said to be ACOTYLEDONOUS. But this term is usually applied only to cellular plants, which, having no sexual apparatus, can have no seeds (470, 393). Those seeds of flowering plants, which appear to have no cotyledons, owe their appearance to the cotyledons being consolidated. *Ex.* Cuscuta, Lecythis, Olynthia.

516. The plumula is very often latent, until it is called into action by the germination of the seed. Sometimes it is undistinguishable from the cotyledons; *sometimes* it is highly developed, and

lies in a furrow of the cotyledon. *Ex.* Maize. In the monocotyledonous embryo it frequently happens that the plumula is rolled up in the cotyledon, the margins of which grow together, so that the whole embryo forms one uniform mass; but as soon as germination commences the parts separate.

517. The radicle elongates downwards, either directly from the base of the embryo, or after previously rupturing the integument of the base. Plants with the first character are called EXORHIZÆ; with the second, ENDORHIZÆ.

518. The endorhizous embryo is very common in monocotyledons; the exorhizous in dicotyledons. These characters of the radicle are, however, far from being constant in those great divisions of the vegetable kingdom.

519. The direction of the embryo, with respect to the seed, will depend upon the relation that the integuments, the raphe, chalaza, hilum, and micropyle, bear to *each other.*

520. If the nucleus be inverted, the embryo will be erect, or *orthotropous*. *Ex*. Apple.

521. If the nucleus be erect, the embryo will be inverted, or *antitropous*. *Ex*. Nettle.

522. If the micropyle is at neither end of the seed, the embryo will be neither erect nor inverted, but will be in a more or less oblique direction with respect to the seed; *Ex*. Primrose; and is said to be *heterotropous*.

523. When the seed is called into action, germination takes place. The juices of the plant, which before were insipid, immediately afterwards abound with sugar; *Ex*. Barley; and growth commences.

524. This growth is in the first instance caused by the absorption of water by the seed, and by the expulsion of superfluous carbon by the cotyledons, in the form of carbonic acid gas.

XVIII. FLOWERLESS PLANTS.

525. Many plants not being increased by seeds, the result of the mutual action of sexual apparatus (470), are flowerless, and destitute of organs of fructification.

526. Such are propagated by what are called organs of reproduction, which have no other analogy with the organs of fructification than that both perpetuate the species.

527. The reproductive organs of flowerless plants vary according to the tribes of that division of the vegetable kingdom, and have so little relation to each other, that each principal tribe may be said to have its own peculiar method of propagation.

528. The principal tribes are *Ferns* (529), *Mosses* (535), *Lichens* (541), *Algæ* (542), and *Fungi* (543).

529. FERNS are increased by little bodies called *sporules*, enclosed within

cases named *thecæ*, which often grow in clusters or *sori*, from the veins of the under sides of the leaves, or from beneath the cuticle. The latter, when it encloses the *thecæ*, is termed the *indusium*.

530. The indusium separates from the leaf in various ways, in consequence of the growth of the thecæ beneath it.

531. The thecæ have frequently a stalk which passes up one side, and finally, curving with their curvature, disappears on the opposite side.

532. The part where the stalk of the theca is united with its side is called the *annulus*.

533. These thecæ may be considered minute leaves, having the same gyrate mode of developement as the ordinary leaves of the tribe; their stalk the petiole, the annulus the midrib, and the theca itself the lamina, the edges of which are united.

534. They would therefore be analogous to carpella, if it appeared that they

were influenced by the action of any vivifying matter.

535. Mosses are increased by sporules (529), contained within an *urn* or theca, placed at the apex of a stalk or *seta*, bearing on its summit a kind of loose hood, called a *calyptra*, and closed by a lid or *operculum*.

536. The inside of the theca has a central axis or *columella*, and the orifice beneath the operculum is closed by teeth-like processes, or a membrane, called the *peristomium*.

537. The number of the teeth of the peristomium is always some multiple of four.

538. The calyptra originally grew from the base of the stalk; but when the stalk elongated, the calyptra was torn away from its base and carried up, surrounding the theca.

539. The calyptra may be understood to be a convolute leaf; the operculum another; the peristomium, one or more whorls of minute flat leaves; and the

theca itself to be the excavated distend
apex of the stalk, the cellular substar
of which separates in the form of sporul

540. There are also in mosses orga
called anthers by some, which do 1
appear analogous to the male appara
of flowering plants, and the nature
which has not been demonstrated.

541. LICHENS are propagated by s
rules, included within little membranc
cases, which lie within a denuded p
tion of their own central substance, cal
the *scutellum*, *apothecium*, or *shield*.

542. ALGÆ increase by sporules, wh
are usually formed by a separation of c
lular tissue, within the substance of t
plants themselves.

543. FUNGI have a similar mode
propagation. In some of the most hig
developed of the tribe, the part in wh
the sporules lie is distinct in appeara
from the rest, and called the *hymenium*

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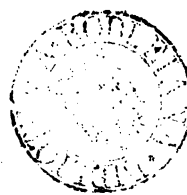
N.B. The Numbers refer to the Paragraphs.

THE END.



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